

Electrobisium acutum Cockerell, a cheiridiid pseudoscorpion from Burmese amber, with remarks on the validity of the Cheiridioidea (Arachnida, Chelonethi)

M.L.I. JUDSON

Muséum national d'Histoire naturelle, Laboratoire de Zoologie (Arthropodes), 61 rue de Buffon, F-75231 Paris Cedex 05, France

SYNOPSIS. *Electrobisium acutum* Cockerell is redescribed from a specimen cut from the block of Burmese amber containing the holotype. The presence of strong spines on the carapace and tergites indicates that *E. acutum* may be closely related to extant South African or Taiwanese species of the genus *Cryptocheiridium* Chamberlin. *Electrobisium* and *Cryptocheiridium* are not synonymized, however, due to insufficient knowledge of *E. acutum* (the type species of *Electrobisium*) and problems with the definition of *Cryptocheiridium*. The superfamily Cheiridioidea, containing the families Cheiridiidae and Pseudochiridiidae, is removed from synonymy with the Garypoidea and regarded as the sister group of the Cheliferoidea.

INTRODUCTION

Only two pseudoscorpion species have been reported from Burmese amber: *Electrobisium acutum* Cockerell, 1917 and *Garypus burmiticus* Cockerell, 1920. The original descriptions (Cockerell, 1917, 1920) allow almost nothing to be said about the systematic position of these species, with the result that they have rarely been considered by subsequent authors. The types were re-examined by Judson (1997), who tentatively assigned *Garypus burmiticus* to the recent genus *Amblyolpium* Simon (family Olpiidae) and placed *Electrobisium* Cockerell in the family Cheiridiidae.

The Burmese amber pseudoscorpions in the collections of the Natural History Museum are difficult to study because of the thickness of the amber and the abundance of other inclusions. Although the blocks have been cut into slabs, the pseudoscorpions are usually too far from the surface to be examined adequately. However, a small piece containing a specimen of *E. acutum* has been cut from one of the slabs. Despite being distorted and partly obscured by debris, this specimen can be examined in sufficient detail to show that it belongs to the Cheiridiidae and that it is probably closely related to Recent species of the genus *Cryptocheiridium* Chamberlin. The following description is based on this non-type specimen, which was not mentioned by Cockerell. There can be little doubt that it is conspecific with the holotype, since the latter also has carapacial and tergal spines and came from the same block.

SYSTEMATIC DESCRIPTIONS

Order CHELONETHI Thorell, 1883

Superfamily CHEIRIDIOIDEA Hansen, 1894

DISCUSSION. The superfamily Cheiridioidea has traditionally included the Cheiridiidae, Pseudochiridiidae (sometimes considered a subfamily of Cheiridiidae) and Sternophoridae, although Chamberlin (1931: 234–235) noted that 'in some ways this group of three rare families is an unnatural one'. In a cladistic analysis of the

pseudoscorpion families, Harvey (1992) found the Sternophoridae to be the sister group of the Cheliferoidea, while the Cheiridiidae and Pseudochiridiidae formed the monophyletic sister group of the clade Garypidae + Larcidae. This led Harvey to erect the monotypic superfamily Sternophoroidea and synonymize the Cheiridioidea with the Garypoidea.

Unfortunately, Harvey's analysis was complicated by the fact that his unweighted data support a sister-group relationship between the Cheiridioidea and Fealloidea. Harvey rejected this result and instead imposed a sister-group relationship between the Fealloidea and Chthonioidea by a *posteriori* weighting of a single character (presence of trichobothria *ds*). If, as this weighted solution implies, the characters that originally placed the Fealloidea within the Garypoidea are misleading, should they be regarded as any more reliable for determining the relationships of the Cheiridioidea?

There are nine putative synapomorphies uniting the Cheiridioidea (Cheiridiidae and Pseudochiridiidae) with one or more clades of the Ellassommatina in Harvey's preferred cladogram. It could be argued that these represent parallelisms in the case of the Fealloidea and Garypoidea (*s.l.*), and that it would be even less parsimonious to treat them as such in Cheiridioidea and the remaining Garypoidea. However, I suggest that these characters have been misinterpreted as synapomorphies.

Harvey's (1992) characters 52 (ocular tubercle present) and 85 (arolia longer than claws) can be ignored because the Cheiridioidea show the plesiomorphic states (interpreted as reversals by Harvey).

Characters 51 (carapace sub-triangular) and 123 (body ovoid) are evidently correlated: an oval body shape entails a broadening of the carapace (the Feallidae are exceptional in this respect, due to their unique prosomal modifications). Even if a broad body were accepted as apomorphic, the subjectivity of this character makes it difficult to code in many cases. In *Pycnocheiridium* Beier, for example, the shape of the body (including carapace and coxae) is similar to that found in most Cheliferoidea. A broadened body is also usually correlated with a broadening of the posterior coxae (character 66), though the Feallidae and Geogarypidae provide exceptions. The 'garypoid' facies of the Pseudogarypidae (presumably part of the ground-plan for Fealloidea) make the polarity of coxal shape ambiguous. Characters 49 (anterior margin sinuous) and 53 (eyes

removed from anterior margin) are also subjective, being correlated with the presence of a 'cucullus' (With, 1906). It is often difficult to decide how intermediate forms should be scored for these characters, which again reflect carapace shape.

Character 125 (setae curved) is probably more general than Harvey implies. Many Cheliferoidea have strongly curved setae, and truly straight setae are not found in any pseudoscorpions (except when they are secondarily thickened and spine-like).

Character 120 (sternite XI enclosing anus) is particularly interesting. Chamberlin (1931) and Harvey (1992) believed that the primitive state in pseudoscorpions was to have segment XI divided into a tergite and sternite, which became secondarily fused in some groups. Because this segment is undivided in most families (including the Chthonioidea and Fealloidea), it is more parsimonious to assume that the reverse is true. Segment XI is only divided into a separate tergite and sternite in Geogarypidae, Garypidae, Cheiridioidea and Cheliferoidea. The ventral displacement of the anal segment (XII) has subsequently led to its becoming surrounded by sternite XI in the Garypidae, Pseudochiridiidae and Cheiridiidae (except in Pycnocheiridiinae and *Apocheiridium*). The distribution of this character suggests that it has arisen independently in all three families.

It therefore appears that most of the characters used by Harvey (1992) to place the Cheiridioidea within the Garypoidea are either miscoded or ambiguous. The traditional arrangement of a sister group relationship between the Cheiridioidea and Cheliferoidea is preferred here. Potential synapomorphies for this clade (Monosphyronida minus Sternophoridae) include the complete fusion of the basi- and telotarsi, the presence of dentate to clavate vestitural setae, the loss of the posterior pair of eyes and the loss of reflective tapeta from the anterior pair. An additional synapomorphy uniting these groups may be the presence of a fibrous envelope around the flagellar tunnel of the spermatozoa (Callaini & Dallai, 1994), but no information is available yet about the spermatozoa of Pseudochiridiidae and Sternophoridae.

Family **CHEIRIDIIDAE** Hansen, 1894
Genus **ELECTROBISIUM** Cockerell, 1917

TYPE SPECIES. *Electrobisium acutum* Cockerell, 1917 (by original designation).

DISTRIBUTION. Burmese amber, Hukawng Valley, Myanmar (Burma); probably Upper Cretaceous (see Zherikhin & Ross, 2000).

DIAGNOSIS. Medium-sized Cheiridiidae with strong spines on posterior margins of carapace and tergites I–VII. Palp femur apparently longer than carapace and probably angled posteriorly at proximal end. Chela with seven trichobothria on fixed finger and two trichobothria on movable finger; trichobothria *est* and *t* near middle of fingers.

DISCUSSION. Cockerell's (1917) assignment of *Electrobisium* to the Obisiidae (=Neobisiidae) is puzzling because it is not supported by any of the characters mentioned in the original description. Cockerell simply indicated that *E. acutum* was 'quite unlike the pseudoscorpions described from Baltic amber, though there is a slight superficial resemblance to *Chelififer ehrenbergii*'. *Chelififer ehrenbergii* C. L. Koch & Berendt is a *nomen dubium* (Harvey, 1991), but it probably belongs in the Cheliferoidea. The fact that Koch & Berendt's (1854) figure of *C. ehrenbergii* appears next to that of *Obisium rathkii* C. L. Koch & Berendt (now *Neobisium*

rathkii) – at that time the only fossil neobisiid known – suggests that Cockerell may have confused *Chelififer ehrenbergii* with *Obisium rathkii*. Schawaller (1978) noted that the original description and figures of *E. acutum* were inadequate, but listed *Electrobisium* in the Neobisiidae, as did Harvey (1991).

Electrobisium was transferred to the Cheiridiidae by Judson (1997), without detailed comment. This position is supported by the general appearance of *E. acutum*, the fusion of the femora and patellae of the legs, and the reduced number of chelal trichobothria. The presence of well developed spines on the posterior margin of the carapace and the anterior tergites (hereafter referred to simply as the 'dorsal spines') also suggests that *Electrobisium* might be related to extant species of the genus *Cryptocheiridium* Chamberlin, 1931.

Unfortunately, it is not clear whether *Cryptocheiridium*, as currently defined, is a monophyletic group. This genus was erected by Chamberlin (1931) for two species: *Cheiridium subtropicum* Tullgren (the type species), from South Africa, and *C. formosanum* Ellingsen, from Taiwan. Chamberlin did not see material of either species and merely distinguished the genus in a key, based on the presence of dorsal spines and the fact that 11 tergites are visible in dorsal view. Beier (1932) provided a more detailed diagnosis of the genus, which has since been enlarged to accommodate extant species from central and eastern Africa, Southeast Asia and Australia (Harvey, 1991), as well as a fossil species from Dominican amber (Schawaller, 1981). None of these species show the strong spines present in *C. subtropicum* and *C. formosanum* and their assignment to *Cryptocheiridium* has mainly been based on the robustness of the palps and the number of trichobothria on the movable finger.

The unreliability of the number of trichobothria as a generic character is shown by the existence of an undescribed South African species of *Cryptocheiridium* which has strong dorsal spines and only a single trichobothrium on the movable finger (pers. obs.). Because this species is evidently closely related to *C. subtropicum*, it becomes difficult to separate *Cryptocheiridium* from *Neocheiridium* Beier.

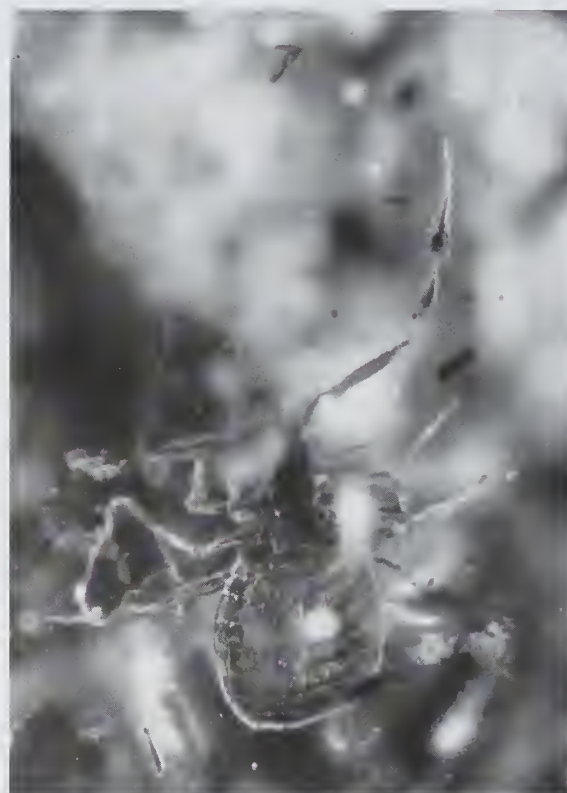
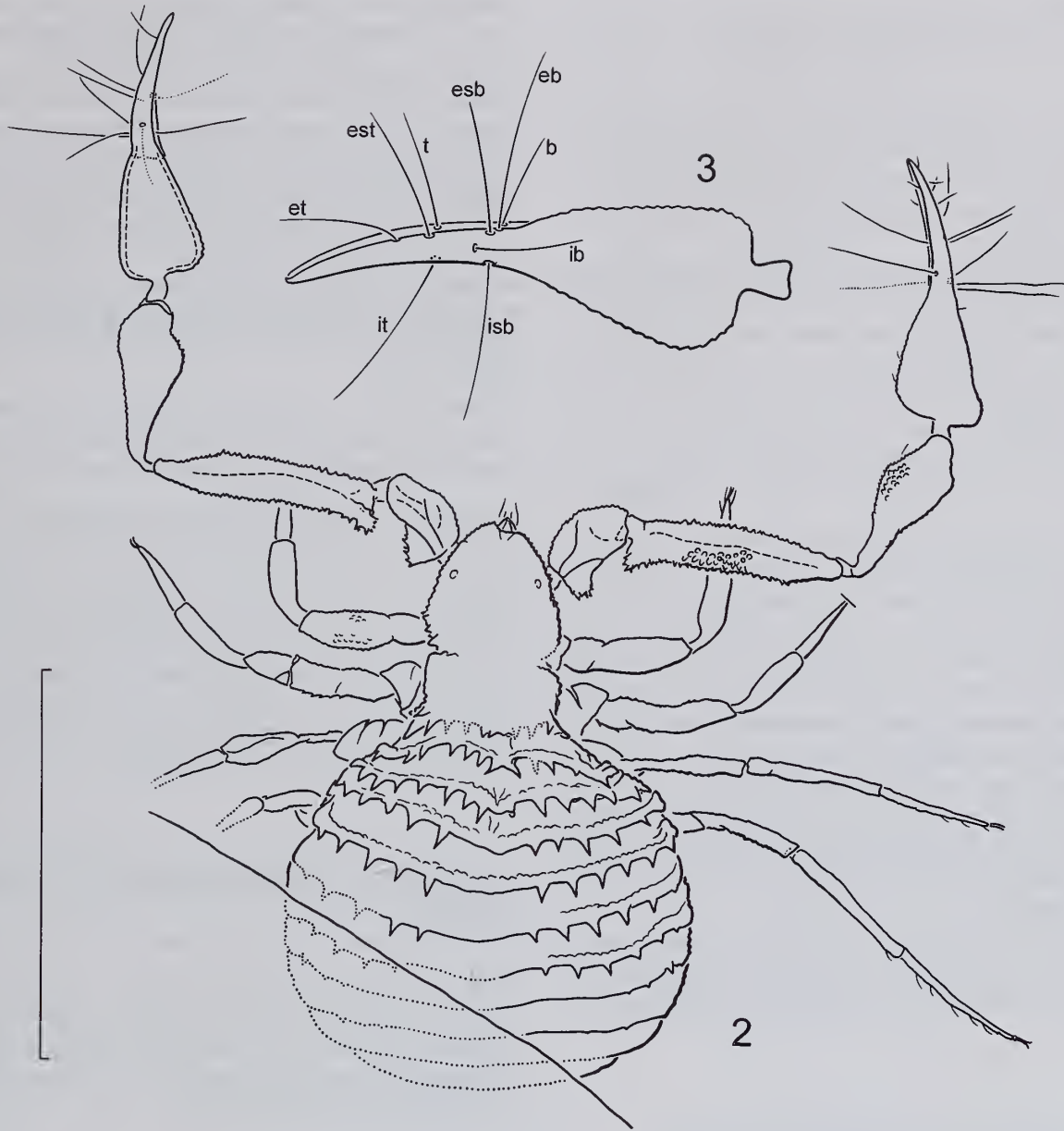


Fig. 1 *Electrobisium acutum*. Holotype, dorsal view of adult, In.19118, Burmese amber. Length of body 0.9mm.



Figs 2, 3 *Electrobisium acutum*. In.19123(3), Burmese amber. **2**, Dorsal view of adult. Surface granulation only shown in part. Size and position of eyes uncertain; other doubtful or reconstructed parts shown by dotted lines. Femoropatella of left leg II broken; opisthosoma incomplete and slightly foreshortened. Diagonal line represents edge of amber. Scale line 0.5 mm. **3**, Chela of right palp, showing trichobothriotaxy (reconstruction, based on left and right chelae; not to scale).

The possibility exists, therefore, that the species currently assigned to *Cryptocheiridium* represent a heterogeneous assemblage. This would not be important in the present context, were it not for the possibility that even the species with strong dorsal spines might not be closely related. The vestitural setae of *C. formosanum* are covered by an exudate that gives them a leaf-like appearance, as in some species of *Neocheiridium* (Mahnert & Aguiar, 1986), whereas those of the South African species lack any covering. *C. formosanum* is also unusual in having a large tubercle on each side of the carapace (Ellingsen, 1912) and a long flange on the anterolateral margin of the palp coxa (pers. obs.).

Given these differences, the possibility that the dorsal spines have arisen more than once has to be considered. This is not difficult to imagine, since they are evidently formed by the elongation of the normal granules found along the posterior margins of the carapace and tergites of most Cheiridiidae. The difference between granules and spines is simply one of degree. This is clearly shown by the ontogeny of the South African *Cryptocheiridium*, in which the spines are only fully formed in the adult.

Because of these doubts concerning the monophyly of

Cryptocheiridium, or even of a clade containing the spined forms, it is difficult to identify relationships between *Electrobisium* and Recent species. This is compounded by the fact that it is not possible to determine with certainty whether the unusual characters seen in *C. formosanum* are present or absent in *E. acutum*. All that can be said for the moment is that *E. acutum* is more similar to *C. formosanum* in having a lower number of spines (12–14 per tergite, versus 18–27 in the South African species). It is, of course, possible that *E. acutum* is not closely related to either the South African or the Taiwanese species. The differences in the shape of the palps and their trichobothriotaxy might be significant, but the distortion of the fossils means that caution is required in interpreting these characters. In view of these problems, *Cryptocheiridium* and *Electrobisium* are retained as separate genera here. From a practical point of view, it would be unfortunate to have *E. acutum* as the type species of an extant genus.

***Electrobisium acutum* Cockerell, 1917**

Figs 1–4

1917 *Electrobisium acutum* Cockerell: 360, fig. 1.

1978 *Electrobisium acutum* Cockerell; Schawaller: 3.

1980 *Electrobisium acutum* Cockerell; Morris: 36.

- 1991 *Electrobisium acutum* Cockerell; Harvey: 334.
 1992 *Electrobisium acutum* Cockerell; Poinar: 220.
 1997 *Electrobisium acutum* Cockerell; Judson: 7.

MATERIAL EXAMINED. Holotype: NHM Pal. Dept. In.19118, adult, Burmese amber, Hukawng Valley, Myanmar (Burma) (presented by R. C. J. Swinhoe, Feb. 1919). Non-types: 1 nymph (protonymph?), in same slab as holotype; 1 adult, off-cut from block containing holotype, NHM Pal. Dept. In.19123(3).

The following description is based on the non-type specimen in the off-cut (BMNH In.19123(3)). Because there is a complete fracture just below the pseudoscorpion (previously repaired, probably with Canada balsam), no further preparation was attempted. The study was therefore limited to the dorsal view of the fossil, some parts of which (particularly the carapace) were obscured by debris. A small, poorly preserved mite larva (*Parasitengona*) is also present in the amber fragment, next to the right chela of the pseudoscorpion.

DESCRIPTION. General appearance of fossil as shown in Figures 2–4. However, this is a caricature of the shape of the living animal: the specimen is distorted, with many parts being unnaturally folded or collapsed. The strong folding of the trochanters and femora of the palps makes them appear thinner than normal. The posterior region of the carapace and the anterior tergites have been constricted laterally, such that the carapace has lost its usual subtriangular shape. Some parts, particularly the carapace, are obscured by a layer of debris lying in the same plane as the specimen. The presence of this layer suggests that the specimen was probably exposed on the surface of the resin for some time, before being covered by a second layer. Part of the posterior end of the body has been lost at the fractured edge of the amber.

Colour chestnut brown. Setae small (only a few visible on palps and leg tarsi). Carapace with a deep anterior furrow; presence or absence of posterior pit could not be determined; posterior margin



Fig. 4 *Electrobisium acutum*, dorsal view of fossil, In.19123(3), Burmese amber. Length of body 0.7mm.

with about 10 long, sharp spines; eyes apparently small (observation and figure doubtful). At least ten tergites visible dorsally, but end of body missing; tergites I–VI with 10–12 spines (maximum length about 0.025 mm), similar to those of carapace, tergite VII with only 6 small spines, posterior tergites without spines. Palps attenuate; with strong granulation, giving the margins a toothed appearance; posterior margin of femur strongly produced proximally, but this might be an artefact of folding; patella clavate; hand sub-triangular in outline; trichobothriotaxy as shown in Fig. 3, fixed finger with seven trichobothria, movable finger with two trichobothria. Anterior legs moderately robust, posterior legs elongate; femora fused with patellae; claws normal; arolia apparently small. Ventral surfaces not clearly visible.

Measurements (in mm); body length >0.7 (about 0.9 in holotype); carapace length ca. 0.26 mm; palp femur $0.29 \times >0.06$, patella $0.22 \times >0.085$, chela length 0.37, hand 0.20×0.105 , fingers 0.18 long.

REMARKS. The holotype specimen (identified by comparison with Cockerell's figure) is distorted in a similar way to the specimen described above, though the abdomen has a more normal (less rounded) shape (Fig. 1). The contraction of the carapace in the holotype has left the trochanter of leg III visible on both sides in dorsal view, which Cockerell incorrectly drew as continuations of the first tergite. The conspecificity of the two specimens is supported by the presence of dorsal spines in the holotype (these are difficult to see and were overlooked by Cockerell).

OTHER PSEUDOSCORPIONS IN BURMESE AMBER

Other Burmese amber pseudoscorpions were briefly examined during a visit to the NHM. Most of these fossils are fragmentary, usually representing parts of palps. It is clear that there is a diverse fauna in the amber, including representatives of the Chthonioidea, Garypoidea, Cheiridioidea and Cheliferoidea.

ACKNOWLEDGEMENTS. Fossils in the Palaeontology Department of the Natural History Museum, London were examined through the courtesy of Ms J. G. Darrell and Mr A. J. Ross. Material of extant *Cryptocheiridium* species was kindly loaned by Mrs L. Brown (Transvaal Museum, Pietermaritzburg) and Dr G. E. E. Söli (Zoologisk Museum, Oslo). Helpful comments on the text were provided by Mark Harvey (Western Australian Museum, Perth). Thanks also go to Mr Peter York (NHM) for photography.

REFERENCES

- Beier, M. 1932. Pseudoscorpionidea II. Subord. C. Cheliferinea. *Das Tierreich*, **58**: 1–294.
 Callaini, G. & Dallai, R. 1994. The spermatozoon of pseudoscorpions (Arachnida). *Bollettino dell'Accademia Gioenia di Scienze naturali*, **26** [1993]: 35–52.
 Chamberlin, J. C. 1931. The arachnid order Chelonethida. *Stanford University Publications, University Series*, (Biol. Sci.) **7** (1): 1–284.
 Cockerell, T. D. A. 1917. Arthropods in Burmese amber. *American Journal of Science*, (4) **44**: 135–138.
 ——— 1920. Fossil arthropods in the British Museum – I. *Annals and Magazine of Natural History*, (9) **5**: 273–279.
 Ellingsen, E. 1912. H. Sauter's Formosa-Ausbeute. Pseudoscorpions from Formosa. I. *Nytt Magazin for Naturvidenskapene*, **50**: 121–128.
 Harvey, M. S. 1991. *Catalogue of the Pseudoscorpionida*. 726 pp. Manchester University Press, Manchester.
 ——— 1992. The phylogeny and classification of the Pseudoscorpionida (Chelicerata: Arachnida). *Invertebrate Taxonomy*, **6**: 1373–1435.

- Judson, M. L. I.** 1997. Catalogue of the pseudoscorpion types (Arachnida: Chelonethi) in the Natural History Museum, London. *Occasional Papers on systematic Entomology*, **11**: 1–54.
- Koch, C. L. & Berendt, G. C.** 1854. Die in Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt. In: Berendt, G. C. *Die im Bernstein befindlichen Organischen Reste der Vorwelt Gesammelt in Verbindung mit mehreren Bearbeitet und Herausgegeben*, **1** (2): 1–124, 17 pls (Nicolai, Berlin).
- Mahnert, V. & Aguiar, N. O.** 1986. Wiederbeschreibung von *Neocheiridium corticum* (Balzan, 1890) und Beschreibung von zwei neuen Arten der Gattung aus Südamerika (Pseudoscorpiones, Cheiridiidae). *Bulletin de la Société entomologique Suisse*, **59**: 499–509.
- Morris, S. F.** 1980. *Catalogue of the type and figured specimens of fossil Crustacea (excl. Ostracoda), Chelicerata, Myriapoda and Pycnogonida in the British Museum (Natural History)*. British Museum (Natural History), Publication no. 828, 53 pp, 3 pls.
- Poinar, G.** 1992. *Life in amber*. 350 pp. Stanford University Press, Palo Alto.
- Schawaller, W.** 1978. Neue Pseudoskorpione aus dem Baltischen Bernstein der Stuttgarter Bernstein Sammlung (Arachnida: Pseudoscorpionidea). *Stuttgarter Beiträge zur Naturkunde*, (B) **42**: 1–22.
- 1981. Cheiridiidae in Dominikanischem Bernstein, mit Anmerkungen zur morphologischen Variabilität (Stuttgarter Bernsteinsammlung: Arachnida, Pseudoscorpionidea). *Stuttgarter Beiträge zur Naturkunde*, (B) **75**: 1–14.
- With, C. J.** 1906. The Danish expedition to Siam 1899–1900. III. Chelonethi. An account of the Indian false-scorpions together with studies on the anatomy and classification of the order. *Det Kongelige Danske Videnskabernes Selskabs Skrifter*, (7) **3**: 1–214, 1 map, pls I–IV.
- Zherikhin, V. V. & Ross, A. J.** 2000. The history, geology and age of Burmite (Burmese amber). *Bulletin of the Natural History Museum, London, Geology*, **56**: 3–10.